

## Claims

1. An optical disc having recorded therein a digital stream divided into  $n$  segments, wherein

5 an interleave unit is recorded in front of an  $i$ th segment to be played back in an  $i$ th place, where each of  $i$  and  $n$  is an integer that satisfies  $i < n$ , and the interleave unit includes one of (a) a program to be synchronized with playback of the  $i$ th segment and (b) data to be displayed synchronously with  
10 playback of the  $i$ th segment.

2. The optical disc of Claim 1, wherein

the interleave unit includes ending time information that indicates at which point on a playback time axis of the digital  
15 stream the program or the data should be deleted from a memory.

3. The optical disc of Claim 1, wherein

the interleave unit includes start time information that indicates at which point on a playback time axis of the digital  
20 stream the program or the data becomes usable.

4. The optical disc of Claim 1, wherein

a copy of the interleave unit is recorded between the  $i$ th segment and an  $i+1$ th segment.

5. The optical disc of Claim 4, wherein  
a boundary between the  $i$ th segment and the  $i+1$ th segment  
falls in a middle of a live range of the program or the data.

5 6. The optical disc of Claim 4, wherein  
a boundary between the  $i$ th segment and the  $i+1$ th segment  
falls after a live range of the program or the data.

7. The optical disc of Claim 1, wherein  
10 the  $i$ th segment is made of a plurality of access units,  
each access unit containing video data having an intra picture,  
and the optical disc has recorded therein map information that  
shows the interleave unit in association with one of an address  
and a playback time of each of the access units belonging to  
15 the  $i$ th segment.

8. The optical disc of Claim 1, wherein  
 $i \geq 2$ , and a boundary between the  $i$ th segment and an  $i-1$ th  
segment corresponds to a start point of a live range of the  
20 program or the data on a playback time axis of the digital stream.

9. The optical disc of Claim 8, wherein  
the live range is a section on the playback time axis,  
during which the program or the data becomes usable.

10. The optical disc of Claim 1, wherein

the program is an event handler that is driven by an event,  
and an interleave unit including the event handler is recorded  
in front of a time at which the event occurs on a playback time  
5 axis of the digital stream.

11. The optical disc of Claim 10, wherein

the event is one of (a) an event indicating that a current  
playback time point has reached a predetermined time on a  
10 playback time axis, (b) an event indicating that a user operation  
is made during a predetermined time duration of the playback  
time axis, (c) an event occurring prior to playback according  
to a playback path, (d) an event occurring after playback  
according to a playback path, (e) an event generated by the  
15 playback apparatus, and (f) an event generated by another  
program.

12. The optical disc of Claim 1, further having recorded  
therein interleave-unit general information that shows  
20 identifiers of a plurality of interleave units recorded in the  
optical disc, in association with a size and a live range of  
a corresponding program or data.

13. The optical disc of Claim 1, further having recorded  
25 therein playlist information and a dynamic scenario, wherein

the playlist information defines a playback path by disposing pieces of information indicating playback sections of video data according to a playback order, the dynamic scenario defines a video title by showing a playback procedure of at least one playback path, and the interleave unit contains an identifier that shows, as a live range of the program or the data, one of a playback path, a playback section, an entire video title, and a chapter of the video title.

10 14. The optical disc of Claim 1, wherein

the interleave unit contains a locator that contains drive information and path information, the drive information indicating a drive to which the program or the data is to be read, and the path information indicating in which layer of a layer structure of the drive the program or the data exists.

15. A playback apparatus for an optical disc having recorded therein a digital stream, the playback apparatus comprising:

a reading unit operable to read, from the optical disc, an  $i$ th segment to be played back in an  $i$ th place from among  $n$  segments constituting the digital stream, together with an interleave unit preceding the  $i$ th segment, where each of  $i$  and  $n$  is an integer that satisfies  $i < n$ ;

a playback unit operable to play back the read  $i$ th segment;

25 and

a processing unit operable to perform synchronous processing using a program or data included in the read interleave\_unit, in synchronization with playback of the ith segment.

5

16. The playback apparatus of Claim 15, comprising:

a memory operable to store the read interleave unit; and

a track buffer operable to store the read ith segment,

wherein

10 the playback unit receives supply of the ith segment via the track buffer, and the processing unit receives supply of the interleave unit via the memory.

17. The playback apparatus of Claim 16, further comprising

15 a switcher, wherein

the read unit, upon reading a sector of the optical disc, makes a notification of an address of the sector, the switcher (a) writes information read from the sector to the memory when judging that the notified address from the read unit falls within  
20 an area for storing interleave units, and (b) sequentially writes information read from the sector to the track buffer when judging that the notified address from the read unit falls within an area for storing segments, each interleave unit on the memory is made of information that the switcher has written to the  
25 memory, and each segment on the track buffer is made of

information that the switcher has written to the track buffer.

18. The playback apparatus of Claim 17, wherein

in the optical disc, each interleave unit is stored in a  
5 file separately from the digital stream, the optical disc has  
recorded therein file management information that indicates each  
file identifier in association with an address in the optical  
disc of one of the digital stream and an interleave unit, and  
judgment as to whether a current read position is within the  
10 area for storing interleave units or within the area for storing  
segments is performed by referring to the file management  
information.

19. The playback apparatus of Claim 16, wherein

15 in the optical disc, each interleave unit is stored in a  
file separately from the digital stream, the optical disc has  
recorded therein file management information that indicates each  
file identifier in association with an address in the optical  
disc of one of the digital stream and an interleave unit, and  
20 the read unit, before performing the reading, opens each file  
for specifying the memory as a reading destination for a file  
storing an interleave unit, and specifying the track buffer as  
a reading destination for a file storing the digital stream.

25 20. The playback apparatus of Claim 16, wherein

the interleave unit contains ending time information, and the processing unit deletes the interleave unit from the memory when a current playback time point of the playback unit has reached an ending time that the ending time information indicates.

21. The playback apparatus of Claim 16 further comprising a virtual machine subunit, wherein

the processing unit, upon request by an application program, supplies the program or the data in the interleave unit on the memory to a work area of the virtual machine subunit, and has the virtual machine subunit to execute the program or the data.

22. The playback apparatus of Claim 21, wherein

the interleave unit contains start time information, and the processing unit supplies the program to the work area of the virtual machine subunit upon request by the application program when the current playback time point of the playback unit has reached a start time that the start time information indicates, and the current playback time point of the playback unit has not reached the start time, the processing unit does not supply the program to the work area of the virtual machine subunit, even upon request by the application program.

23. The playback apparatus of Claim 15, wherein

a boundary between the  $i$ th segment and an  $i+1$ th segment falls in a middle of a live range of the program or the data, a copy of the interleave unit is recorded between the  $i$ th segment and the  $i+1$ th segment, and the read unit reads the copy from the optical disc when a random access is performed to the  $i$ th segment.

24. The playback apparatus of Claim 15, wherein

a boundary between the  $i$ th segment and an  $i+1$ th segment falls after a live range of the program or the data, a copy of the interleave unit is recorded between the  $i$ th segment and the  $i+1$ th segment, the read unit reads the  $i$ th segment when the playback unit performs normal playback, and the playback unit, when performing reverse playback, reads the  $i+1$ th segment among the  $n$  segments, together with the copy of the interleave unit preceding the  $i+1$ th segment.

25. The playback apparatus of Claim 15, wherein

the  $i$ th segment is made of a plurality of access units, each access unit containing video data having an intra picture, the optical disc has recorded therein map information that shows the interleave unit in association with one of an address and a playback time of each of the access units belonging to the  $i$ th segment, and the read unit performs reading of the interleave



unit, by referring to the map information.

26. The playback apparatus of Claim 15, wherein  
the processing unit includes a virtual machine subunit,  
5 the playback unit plays back the digital stream and generates  
an event synchronized with the playback, and the virtual machine  
subunit, when the playback unit has generated the event, executes  
the program in the interleave unit.

10 27. The playback apparatus of Claim 26, wherein  
the event is one of (a) an event indicating that a current  
playback time point has reached a predetermined time on a  
playback time axis of video data, (b) an event generated by the  
playback apparatus, and (c) an event generated by another  
15 program.

28. The playback apparatus of Claim 27, wherein  
the optical disc has recorded therein mark information  
that defines a predetermined<sup>3</sup> time point and a predetermined time  
20 interval on the playback time axis, and the playback unit  
generates the event according to the mark information.

29. The playback apparatus of Claim 27, comprising a reception  
unit operable to receive a user operation, wherein  
25 the event is an event that indicates that the reception

unit has received a user operation in a predetermined time duration of the playback time axis of the video data.

30. The playback apparatus of Claim 15, wherein

5 the optical disc has recorded therein interleave-unit general information being management information for a plurality of interleave units recorded on the optical disc, the playback apparatus includes a memory and a playback control unit that is operable to judge, according to the interleave-unit general  
10 information, whether the interleave units are storable in the memory, and the read unit reads part or all of the interleave units when the playback control unit has judged affirmatively.

31. The playback apparatus of Claim 15, wherein

15 the optical disc has recorded therein playlist information that defines a playback path by disposing pieces of information indicating playback sections of the digital stream according to a playback order, and the playback control unit controls the read unit and the playback unit so as to play back the digital  
20 stream according to the playlist information.

32. The playback apparatus of Claim 31, wherein

each interleave unit contains an identifier, and the playback control unit, in playing back the digital stream  
25 according to the playlist information, controls the read unit

to read, from the optical disc, one of (a) an interleave unit containing an identifier of the playlist information and (b) an interleave unit containing an identifier of information that indicates a playback section of the playlist information.

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33. The playback apparatus of Claim 31, wherein

the optical disc has recorded therein a dynamic scenario, the dynamic scenario defining a title by showing a playback procedure of at least one playback path shown by playlist  
10 information, the playback control unit controls the read unit to read, from the optical disc, one of (a) an interleave unit containing an identifier of the title corresponding to the dynamic scenario and (b) an interleave unit containing an identifier of a chapter included in the title corresponding to  
15 the dynamic scenario.

34. The playback apparatus of Claim 15, wherein

each interleave unit contains a locator that contains drive information and path information, the drive information  
20 indicating a drive to which the program or the data is to be read, the path information indicating in which layer of a layer structure of the drive the program or the data is to be disposed, and the playback apparatus disposes the program or the data in the layer indicated by the path information.

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35. A playback program for an optical disc having recorded therein a digital stream, the playback program comprising:

a reading step of reading an  $i$ th segment to be played back in an  $i$ th place, from among a plurality of segments  
5 constituting the digital stream;

a playback step of playing back the read  $i$ th segment; and

a processing step of performing synchronous processing using a program or data included in the read interleave unit, in synchronization with playback of the  $i$ th segment.

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36. A playback method for an optical disc having recorded therein a digital stream, the playback method comprising:

a reading step of reading an  $i$ th segment to be played back in an  $i$ th place, from among a plurality of segments  
15 constituting the digital stream;

a playback step of playing back the read  $i$ th segment; and

a processing step of performing synchronous processing using a program or data included in the read interleave unit, in synchronization with playback of the  $i$ th segment.

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37. A recording method for an optical disc, the recording method comprising:

a step of creating application data; and ,

a step of recording the created application data to the

25 optical disc, wherein



the application data contains a digital stream divided into  $n$  segments and an interleave unit, the interleave unit is recorded in front of an  $i$ th segment to be played back in an  $i$ th place, where each of  $i$  and  $n$  is an integer that satisfies  $i < n$ ,  
5 and the interleave unit includes one of (a) a program to be synchronized with playback of the  $i$ th segment and (b) data to be displayed synchronously with playback of the  $i$ th segment.